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PORTLAND, MAINE METROPOLITAN AREA AIR POLLUTANT EMISSION INVENTORY

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A summary report is presented of the Portland, Maine, air pollutant inventory. The study area consists of four counties surrounding the cities of Portland, Lewiston and Auburn. This area covers approximately 2,600 sq. miles and had a 1969 population of 400,000. A grid coordinate system was used to show the geographical distribution of emissions within counties. All sources of emissions were divided into five categories: transporation, stationary fuel combustion, solid-waste disposal, industrial processes, and evaporative losses.

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Prepared by

David V. Mason

U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE

Environmental Health Service

National Air Pollution Control Administration

Division of Air Quality and Emission Data

Durham, North Carolina

April 1970

PREFACE

This report, which presents the emission inventory for the Portland, Maine Metropolitan Area, is another in a series of surveys outlining the sources and emissions of air pollutants for major metropolitan areas in the country. These surveys, conducted by the National Inventory of Air Pollutant Emissions and Control Branch of the National Air Pollution Control Administration, provide estimates of the present levels of air pollutant emissions and status of their control. The pollutants, which include sulfur oxides, particulates, carbon monoxide, hydrocarbons and nitrogen oxides, are delineated with respect to source type, season of the year and geographical distribution within the area. The general procedure for the surveys is based upon the rapid survey technique for estimating air pollutant emissions.[1] These reports are intended to serve as aids in the proposing of boundaries of Air Quality Control Regions, as directed by the Air Quality Act of 1967.

ACKNOWLEDGMENTS

Sincere gratitude is extended by the National Air Pollution Control Administration to the many individuals and companies who contributed to this air pollution emission inventory.

Special thanks are extended to Fredrick Pitman of the Environmental Improvement Commission of the State of Maine, who contributed invaluable assistance in the gathering of data for this report.

TABLE OF CONTENTS

	Page
Introduction	1
Summary of Results	3
Description of Study Area	6
Grid Coordinate System	13
Emissions by Category	16
Stationary Fuel Combustion	16
Steam-Electric	16
Industrial	16
Commercial-Institutional	16
Residential	17
Transportation	21
Road Vehicles	21
Aircraft	23
Railroads	23
Vessels	23
Solid Waste Disposal	26
Industrial Process Losses	26
Evaporative Losses	29
Emissions by Jurisdiction	32
Emissions by Grid	37
References	49
Appendix A	50
Appendix B	51

LIST OF TABLES

Table		Page
1	Summary of Air Pollutant Emissions Using English Units.....	4
1A	Summary of Air Pollutant Emissions Using Metric Units.....	5
2	Area and Population Characteristics for Study Area.....	9
3	Number of Industrial Establishments in Study Area.....	12
4	Annual Fuel Consumption for Study Area.....	18
5	Chemical Analysis of Fuel Burned in Study Area.....	19
6	Air Pollutant Emissions from Fuel Combustion in Stationary Sources.....	20
7	Vehicle Miles of Travel for Road Vehicles.....	22
8	Air Traffic Activity at Portland International Airport.....	24
9	Air Pollutant Emissions from Transportation Sources.....	25
10	Solid Waste Disposal Balance.....	27
11	Air Pollutant Emissions from Solid Waste Disposal.....	28
12	Air Pollutant Emissions from Industrial Processes.....	30
13	Hydrocarbon Emissions from Evaporative Losses.....	31
14	Summary of Air Pollutant Emissions in Androscoggin County...	33
15	Summary of Air Pollutant Emissions in Cumberland County.....	34
16	Summary of Air Pollutant Emissions in Sagadahoc County.....	35
17	Summary of Air Pollutant Emissions in York County.....	36
18	Summary of Air Pollutant Emissions from Point Sources.....	39
19	Summary of Air Pollutant Emissions from All Sources.....	41

LIST OF FIGURES

Figure		Page
1	Map of Portland, Maine Study Area and Surrounding Area.....	7
2	Detailed Map of Portland, Maine Study Area.....	8
3	Population Density Map of Portland, Maine Study Area.....	10
4	Grid Coordinate System for Portland, Maine Study Area.....	14
5	Point Source Locations.....	38
6	Sulfur Oxides Emissions Density Map.....	44
7	Particulate Emission Density Map.....	45
8	Carbon Monoxide Emission Density Map.....	46
9	Hydrocarbon Emission Density Map.....	47
10	Nitrogen Oxide Emission Density Map.....	48

INTRODUCTION

This report is a summary of the Portland, Maine, air pollutant emission inventory conducted in January, 1970. Since all inventories are based upon a calendar year, the data and emission estimates presented are representative of 1969 and should be considered as indicating the conditions as existed during that year.

The Study Area, which was chosen on the basis of the distribution of population and air pollution sources, consists of four counties surrounding the cities of Portland, Lewiston and Auburn. This area covers approximately 2,600 square miles and had a 1969 population of 400,000.

A grid coordinate system was used to show the geographical distribution of emissions within counties. The Study Area was subdivided into 80 grid zones ranging in size from 25 square kilometers in the heavily populated and industrialized areas to 400 square kilometers in the rural areas.

All sources of emissions were classified into five categories--transportation, stationary fuel combustion, solid-waste disposal, industrial processes and evaporative losses. Each of these source categories was divided into two subgroups--point sources and area sources. Facilities, which emit large quantities of air pollutants, were considered individually as point sources, while the many remaining contributors such as motor vehicles, residential and commercial fuel users, small industries and on-site refuse burning equipment were considered collectively as area sources. For this report, 35 individual sources, which had emissions greater than 0.25 tons per average annual day for any pollutant, were classified as point sources.

Emissions were estimated by using various indicators such as fuel consumption, refuse burning rates, vehicle-miles, production data, control efficiencies and emission factors relating these indicators to emission rates.[2] These factors represent average emission rates for a

particular source category. Since individual sources have inherent differences that cannot always be taken into consideration, discrepancies between the actual and estimated emissions are more likely in individual sources than in the total emissions for a source category.

As in all emission surveys, the data presented are estimates and should not be interpreted as absolute values. The estimates are, in some cases, partial totals due to the lack of emission factors and production or consumption data. Despite these limitations, the estimates are of sufficient accuracy and validity to define the extent and distribution of air pollutant emissions in the Study Area.

SUMMARY

An estimated 325,000 tons of five major pollutants are emitted annually in the Study Area. The breakdown of these emissions by type of pollutant and source category are summarized in Table 1. The following is a presentation of the relative contribution of different source categories.

Sulfur Oxides	1969 Total - 31,100	tons
	Steam-Electric	57%
	Industrial Fuel Use	25%
	Residential Fuel Use	14%
	Other	4%
Particulates	1969 Total - 10,900	tons
	Solid Waste Disposal	43%
	Stationary Fuel Combustion	25%
	Industrial Processes	16%
	Road Vehicles	12%
	Other	4%
Carbon Monoxide	1969 Total - 220,800	tons
	Road Vehicles	86%
	Solid Waste Disposal	11%
	Other	3%
Hydrocarbons	1969 Total - 35,000	tons
	Road Vehicles	43%
	Evaporative Losses	30%
	Solid Waste Disposal	22%
	Other	5%
Nitrogen Oxides	1969 Total - 27,600	tons
	Stationary Fuel Combustion	47%
	Road Vehicles	38%
	Solid Waste Disposal	11%
	Other	4%

TABLE 1 SUMMARY OF AIR POLLUTANT EMISSIONS IN THE PORTLAND, MAINE STUDY AREA, 1969 (Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Transportation					
Road Vehicles	840	1,360	190,390	14,880	10,580
Others	330	340	3,910	1,100	860
Total	1,170	1,700	194,300	15,980	11,440
Stationary Fuel Combustion					
Industry	7,670	1,030	100	100	3,750
Steam-Electric	17,670	790	0	250	8,260
Residential	4,200	960	1,640	500	1,100
Commercial-Institutional	0	0	0	0	0
Total	29,540	2,780	1,740	850	13,110
Solid Waste Disposal					
Incineration	120	610	2,680	50	180
Open Burning	260	4,120	21,900	7,730	2,830
Total	380	4,730	24,580	7,780	3,010
Industrial Processes	0	1,690	150	0	0
Evaporative Losses	--	--	--	10,350	--
Total All Sources	31,090	10,900	220,770	34,960	27,560

DESCRIPTION OF STUDY AREA

The Study Area for the Portland, Maine, Metropolitan Area Air Pollution Emission Inventory covers the southern portion of the State of Maine. As can be seen in Figure 1, Portland is about 170 miles from the nearest metropolitan area, Boston.

The four counties included in the Study Area (Figure 2) are: Androscoggin, Cumberland, Sagadahoc and York. The Portland Standard Metropolitan Statistical Area (SMSA) lies in Cumberland County and the Lewiston-Auburn SMSA lies in Androscoggin County, but neither SMSA covers the entire county. Sagadahoc County and York County were included to insure that all counties which may have a high rate of growth in future years are included in the Study Area.

The approximate 1969 population for the Study Area was 403,000. Although the Study Area includes 2,600 square miles, the majority of the people live in an urbanized area of only 204 square miles (1960). Table 2, which gives populations by county, and Figure 3, which is a population density map, will give the reader more information on the geographical distribution of the population. The population in the four county area has increased at a slower rate than the nation as a whole. Between 1960 and 1969 the nation's population increased about 12 percent, while the Portland, Maine Study Area increased approximately 3 percent.

TOPOGRAPHY

The Study Area is bounded to the east by the Atlantic Ocean and to the northwest by the White Mountains. The White Mountains are situated about 60 miles from the City of Portland and average 3,000 to 5,000 feet in height. Between the ocean and the mountains is country which is generally open and rolling.

TABLE 1A SUMMARY OF AIR POLLUTANT EMISSIONS IN THE PORTLAND MAINE STUDY AREA, 1969 (Metric Tons/Year)*

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Road Vehicles	760	1,230	172,720	13,500	9,600
Others	300	310	3,550	1,000	780
Total	1,060	1,540	176,270	14,500	10,380
Stationary Fuel Combustion					
Industry	6,960	930	90	90	3,400
Steam-Electric	16,030	720	0	230	7,500
Residential	3,810	870	1,500	450	1,000
Commercial-Institutional	0	0	0	0	0
Total	26,800	2,520	1,590	770	11,900
Solid Waste Disposal					
Incineration	110	550	2,430	50	160
Open Burning	240	3,740	19,870	7,010	2,570
Total	350	4,290	22,300	7,060	2,730
Industrial Processes	0	1,530	140	0	0
Evaporative Losses	--	--	--	9,390	--
Total All Sources	28,210	9,880	200,300	31,720	25,010

* Metric Ton = 1000 kilograms

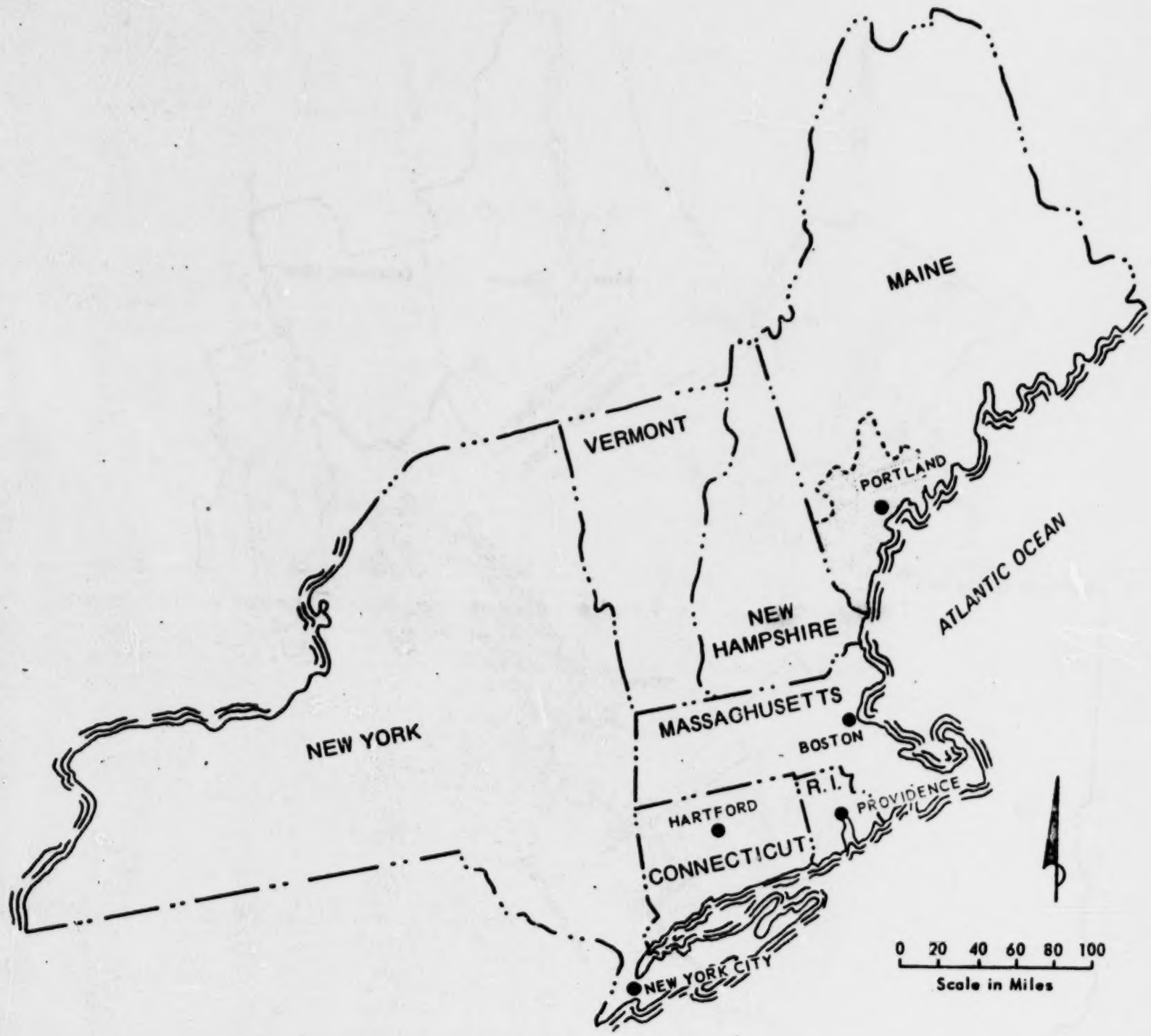


Figure 1. Map of Portland, Maine study area and surrounding states.

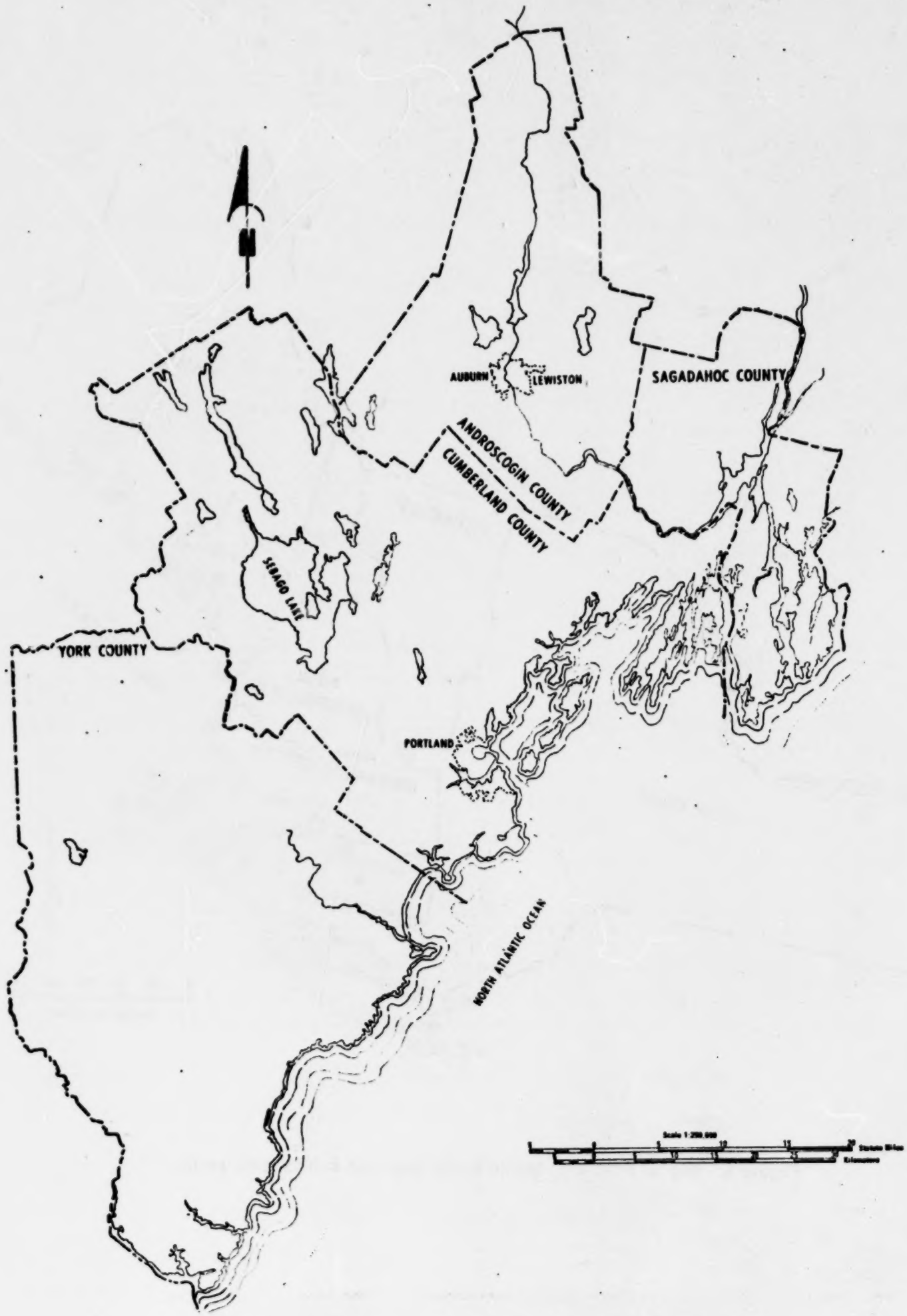


Figure 2. Detailed map of Portland, Maine study area, 1969.

TABLE 2 AREA AND POPULATION CHARACTERISTICS FOR THE PORTLAND MAINE STUDY AREA

County	Land Area (Sq. Mi.)	Population 1960	Population 1969	Population Density (1969)
Androscoggin County	474	86,300	88,900	188
Cumberland County	879	182,800	188,000	214
Sagadahoc County	257	22,800	24,200	94
York County	1,001	99,400	102,600	102
STUDY AREA	2,611	391,300	403,700	155

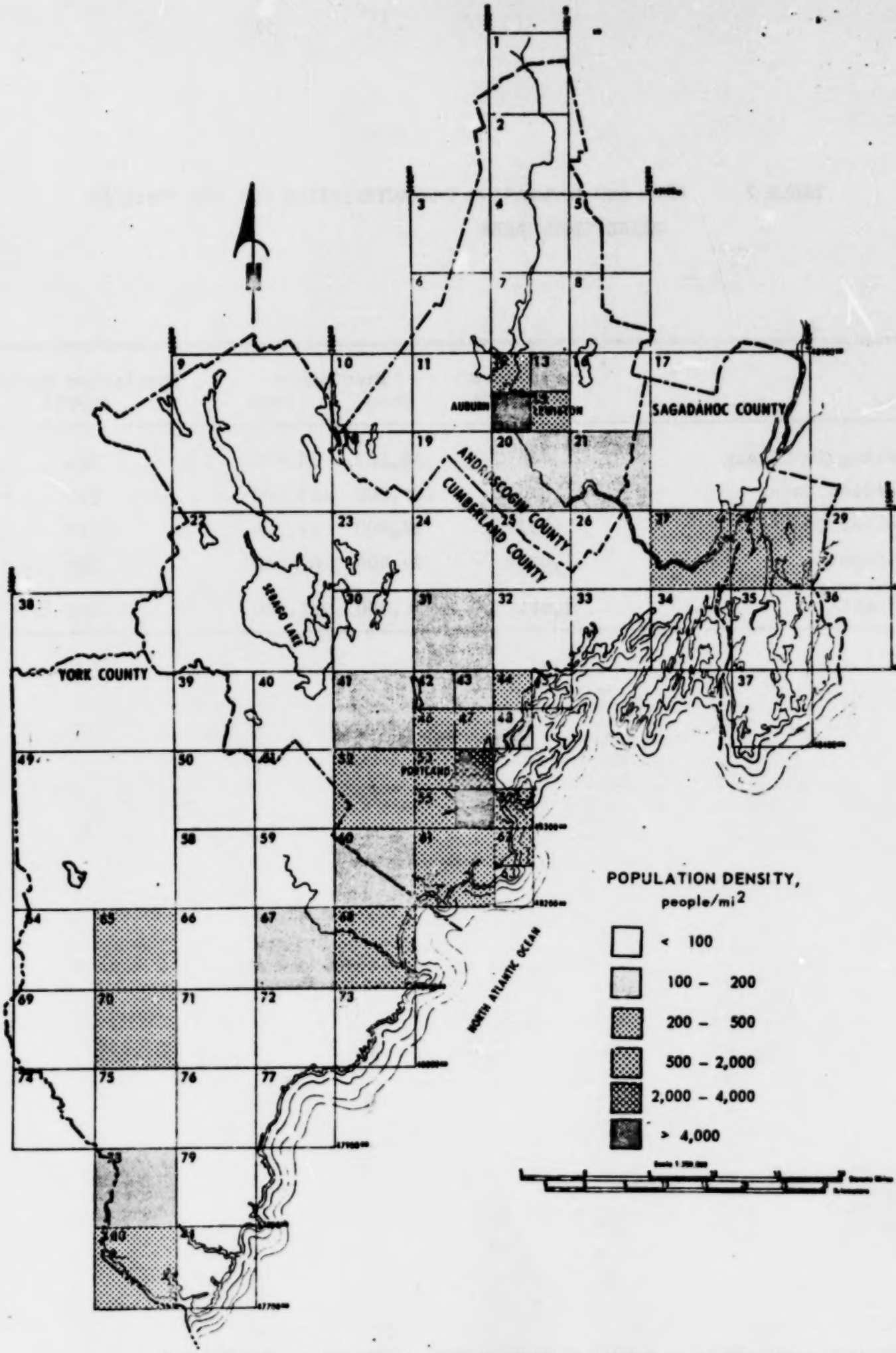


Figure 3. Population density map for Portland, Maine study area, 1969.

CLIMATOLOGY

The Study Area has pleasant summers and falls, cold winters with frequent thaws, and disagreeable springs. Fall has the greatest number of sunny days and the least cloudiness. Winters are quite severe, but begin late and then extend deeply into the normal spring-time.

Winds are generally quite light with the heaviest velocities being confined mostly to March and November. Even in these months the occasional northeasterly gales have usually lost much of their severity before reaching the coast.

Precipitation, which amounts to about 42 inches a year, is remarkably uniform throughout the year. The White Mountains keep a considerable amount of snow from reaching the Portland Area.

INDUSTRIAL FACTORS

The industry in the Study Area is mainly concerned with agriculture, lumber and paper, and textiles. Except for one pulp mill located near Portland and a few ship building facilities, there is no heavy industry in the Study Area. The number of industrial establishments located in the Study Area is shown in Table 3.

TABLE 3 NUMBER OF INDUSTRIAL ESTABLISHMENTS IN THE PORTLAND MAINE STUDY AREA, 1960

Industry	Androscoggin County	Cumberland County	Sagadahoc County	York County
Food and Tobacco	6	32	3	3
Textiles	38	23	3	24
Paper and Printing	8	10	2	5
Chemicals	5	2	--	8
Lumber and Wood	2	10	--	5
Sand and Gravel	5	4	--	2
Primary and Intermediate Metals	5	5	--	1
Electrical Machinery	3	9	1	3
Transportation and Ordinances	--	4	1	3
Instruments and Miscellaneous	2	4	--	3

GRID COORDINATE SYSTEM

A grid coordinate system, based on the Universal Transverse Mercator Projection (UTM), was used in the Portland, Maine Study Area to indicate the geographical distribution of emissions. A map showing the grid coordinate system is presented in Figure 4.

An evaluation of the available coordinate systems was completed before choosing the UTM system to present emissions in this series of emission inventories. The systems evaluated were the State Plane system, the Longitude-Latitude system and the UTM system. Although each of the systems had valuable qualities, the use of the UTM coordinate system was felt to completely meet the requirements of these emission inventories.

Two primary requirements of the grid coordinate system were used to evaluate each system. One of the requirements was that the grid coordinate system had to have square grid zones, since the data were to be used in meteorological dispersion models. The grid zones, which the UTM system and most of the State Plane systems project, are always square, but the longitude-latitude system projects grid zones that become skewed as the zones become further from the equator. The other quality the grid coordinate system had to possess was consistency. Each emission inventory should be conducted on a grid coordinate system which uses the same reference point throughout the Study Area. Since some air pollutant inventories would include areas in two or more states, the State Plane systems could not be used. However, since the UTM system, as well as the longitude-latitude system, is not referenced to points in individual states, it is not influenced by jurisdiction boundaries. The UTM system was chosen since it was the only coordinate system which could project square grid zones over any Study Area using a common reference point.

The Universal Transverse Mercator Projection is based upon the metric system. Each north-south and east-west grid line, as illustrated

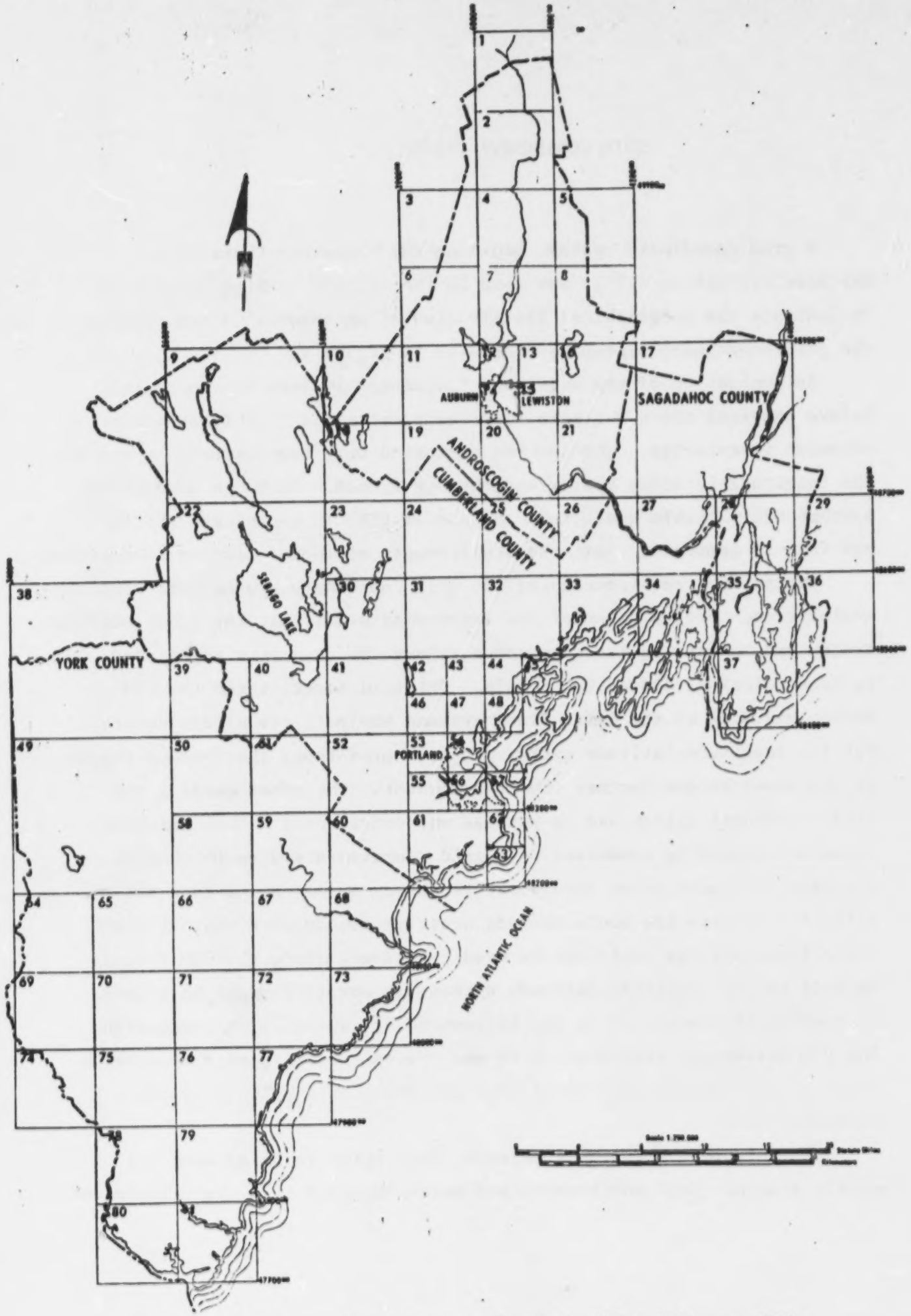


Figure 4. Grid coordinate system for Portland, Maine study area, 1969.

in Figure 4, is identified by a coordinate number expressed in meters. Each point source and grid, using the geographical center of the grid, is identified by a horizontal and vertical coordinate to the nearest 100 meters.

Grid zones of different sizes are used in the grid coordinate system to allow a satisfactory definition of the geographical gradation of emissions and to limit the number of grid zones. Since majority of the emissions is usually concentrated in the populated and industrialized portions of a Study Area, smaller grids are placed over these areas to allow the grid coordinate system to reflect the changes of emissions over short distances. Grid zones smaller than the 25 kilometer grid zones used in this report are not usually warranted because of the inherent inaccuracies in the data. Larger grid zones are used in the rural portions, because a smaller portion of the total emissions usually occurs in lightly populated areas.

EMISSIONS BY CATEGORY

STATIONARY FUEL COMBUSTION

The stationary fuel combustion source category is concerned with four primary sources: industrial facilities, steam-electric plants, residential housing, and commercial and institutional establishments. Four fuels are usually burned in these sources: coal, residual fuel oil, distillate fuel oil and natural gas. Other fuels such as woodwaste and LPG are also included if there is a sufficient amount being burned.

Steam-Electric

METHODOLOGY: Fuel consumption data were acquired on the three power plants from the Central Maine Power Company. Only two of these facilities are situated in the four county area, but the third was included because it was relatively close. Data received on these plants included the weekly fuel consumption for 1969, and the approximate sulfur content of the fuel oil.

RESULTS: The three power plants burn only residual fuel oil for fuel. Approximately 88 percent of all the residual fuel oil burned in the study area is consumed by the three power plants.

Because the power plants are the largest fuel consumers, they are also the largest air pollutant emitters. The power plants account for 63 percent of the sulfur oxides, 63 percent of the nitrogen oxides, and large portions of the other three pollutants.

Industry and Commercial-Institutional

METHODOLOGY: The industry source category and the commercial-institutional source category are usually done separately, but because there was not sufficient information they were combined in this emission inventory.

The total fuel oil combustion in the Study Area and in the individual counties was obtained from state fuel combustion data published by the Bureau of Mines. After proportioning the total fuel into each county on the basis of population, the fuel combustion of industry and commercial-institutional establishments was obtained by deducting that fuel consumed by residential users.

The fuel consumption data for individual sources were obtained with questionnaires. After deducting the emissions attributable to those individual sources, the remaining area source emissions were proportioned into grids on the basis of population.

RESULTS: Four fuels are burned by industry and commercial-institutional establishments in the study area: residual fuel oil, distillate fuel oil, natural gas and coal. Residual fuel oil and distillate fuel oil are the most significant fuels, together they are used to generate 95 percent of the energy used by industry. Table 4 shows the approximate consumption of these fuels by county. Emissions for this category are shown on Table 6.

Residential

METHODOLOGY: Total fuel consumption was analytically obtained for all fuels except natural gas, which was supplied by the Northern Utilities Inc. Fuel oil and coal were obtained using a method based upon the number of housing units burning the fuel, the average number of degree days and the average home heating requirement.[1] The number of housing units burning coal in the study area was estimated by assuming a 25 percent decrease since 1960.[3] In order to estimate the number of homes heating with fuel oil, the housing units burning with gas and coal were deducted from the total housing units in the study area. The remaining housing units were assumed to be heating with oil.

Fuel burned in homes is used for more than space heating. A certain portion of the fuel is used for such purposes as cooking and hot water heating, which remain constant throughout the year. It was estimated that fifteen percent of the natural gas, 5 percent of the oil, and 2 percent of the coal was used for these purposes.

RESULTS: Distillate fuel oil is the predominant fuel used to heat homes in the Portland and Lewiston-Auburn areas. Most of the coal and natural gas are burned in and around the metropolitan areas, while the fuel oil is burned throughout the area. Emissions from residential fuel use can be found in Table 6.

TABLE 4 SUMMARY OF FUEL COMBUSTION IN PORTLAND, MAINE STUDY AREA, 1969

County	Residential	Commercial-Institutional	Industrial	Steam-Electric
Natural Gas (10^6 Cu. Ft./Yr.)				
Androacoggin County	590	220	0	0
Cumberland County	730	260	0	0
Sagadahoc County	0	0	0	0
York County	0	0	0	0
Distillate Fuel Oil (1000 Gal./Yr)				
Androscoggin County	27,100	10,600		0
Cumberland County	59,600	22,300		0
Sagadahoc County	8,900	3,100		0
York County	34,300	12,800		0
Residual Fuel Oil (1000 Gal./Yr.)				
Androscoggin County	0	5,000		0
Cumberland County	0	10,500		92,300
Sagadahoc County	0	1,400		66,500
York County	0	5,700		0
Coal (Tons/Year)				
Androscoggin County	7,700	500		0
Cumberland County	35,900	500		0
Sagadahoc County	5,000	0		0
York County	12,000	0		0

TABLE 5 CHEMICAL ANALYSIS OF FUELS IN THE PORTLAND, MAINE STUDY AREA

	Percent Sulfur	Percent Ash	Percent Volatile Material
Coal	1.50	7.1	33.6
Residual Fuel Oil	1.43		
Distillate Fuel Oil	0.24		
Natural Gas	0.0008		

TABLE 6 AIR POLLUTANT EMISSIONS FROM STATIONARY FUEL COMBUSTION IN THE PORTLAND, MAINE STUDY AREA, 1969 (Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Natural Gas					
Industrial	0	0	0	0	30
Steam-Electric	0	0	0	0	0
Residential	0	10	0	0	80
Commercial-Institutional	0	0	0	0	30
Totals	0	10	0	0	140
Fuel Oil					
Industrial	7,650	990	100	100	3,720
Steam-Electric	17,670	790	0	250	8,260
Residential	2,470	520	130	190	780
Commercial-Institutional	0	0	0	0	0
Totals	27,790	2,300	230	540	12,760
Coal					
Industrial	20	30	0	0	10
Steam-Electric	0	0	0	0	0
Residential	1,720	430	1,510	300	240
Commercial-Institutional	0	0	0	0	0
Totals	1,740	460	1,510	300	250
STUDY AREA	29,530	2,770	1,740	840	13,150

TRANSPORTATION

The transportation source category is concerned with mobile air pollutant sources. Sources in this category include: road vehicles (both gasoline and diesel powered), aircraft, vessels, and railroads. With the exception of aircraft, all the sources are considered area sources.

Road Vehicles

METHODOLOGY: The total motor vehicle activity in the Study Area was obtained from the Maine State Highway Department in the form of total vehicle-miles for each county.

The proportioning of the county vehicle mile data into grids was completed using two methods. The first method utilized traffic flow maps obtained from the State Highway Department. The grid coordinate system was drawn over the maps and the vehicle miles on the major streets and roads were measured for their respective grids. A second method used the population of each grid as the basis of proportioning the vehicle miles. Only those vehicle miles left undistributed by the first method were proportioned by population.

Accurate diesel powered motor vehicle activity was obtained from state diesel fuel consumption figures.[7] These fuel numbers were translated into vehicle miles by assuming all diesel powered vehicles averaged 5.1 miles per gallon.[1]

RESULTS: Vehicle activity in the Study Area was greatest in Cumberland County, but an unusually large amount of vehicle activity is found in York County because of very large numbers of vacationers visiting during the summer. The number of vehicle miles traveled are presented in Table 7.

Road vehicles, a major contributor of three of the pollutants surveyed, were the dominint source within the transportation source category. They contributed 72 percent of the sulfur oxides, 80 percent of the particulates, 98 percent of the carbon monoxide, 96 percent of the hydrocarbons, and 93 percent of the nitrogen oxide. When compared to all sources in the

TABLE 7 VEHICLE MILES TRAVELED BY ROAD VEHICLES IN THE PORTLAND MAINE STUDY AREA, 1969 (1000 u.m./Year)

County	Gasoline Powered	Diesel Powered	Total
Androscoggin County	376,400	6,900	383,300
Cumberland County	1,084,600	19,900	1,104,500
Sagadahoc County	135,600	2,400	138,000
York County	680,000	12,400	692,400
STUDY AREA	2,276,600	41,600	2,318,200

Study Area, road vehicles ranked number one in amount of carbon monoxide and hydrocarbon emitted and number two in nitrogen oxide emissions (Table 1).

Aircraft

METHODOLOGY: Data were obtained from only one airport in the Study Area--Portland International Airport. The data received included number of flights per day and number and type of engines per flight. This information was obtained from a FAA publication and through personal communication with the airport. Information was not secured on the small private airports in the Study Area, because accurate information was not available.

RESULTS: As shown in Tables 1 and 9 aircraft emissions account for a small portion of the total emissions in the transportation source category and in the Study Area. Within the transportation source category, aircraft contribute no more than 3 percent of any pollutant.

Railroads

METHODOLOGY: Information on the fuel consumption of railroads for the State of Maine was obtained from an American Petroleum Institute publication.[8] State totals were proportioned into the individual counties on the basis of population. The county totals were further proportioned into grid zones by evenly distributing the fuel into all grid zones which had railroad activity.

RESULTS: Several hundred tons of hydrocarbons, particulates and nitrogen oxides were emitted in the Study Area.

Vessels

METHODOLOGY: Data were obtained through personal communications with a Port Authority official in Portland. Emissions were estimated on tug boat activity and ships weighing greater than 10,000 tons.

RESULTS: Approximately 650 ships enter and leave the Portland harbor per year. These ships emit about 200 tons of sulfur oxides, but very little of the other pollutants.

TABLE 8 AIR TRAFFIC ACTIVITY AT THE PORTLAND INTERNATIONAL AIRPORT, 1969 (Flights/Year)

	Number of Engines			
	1 Engine	2 Engines	3 Engines	4 Engines
Conventional Jets	0	0	0	0
Fan Jets	0	20	0	0
Turboprop	0	70	0	0
Piston	270	190	0	10

TABLE 9 AIR POLLUTANT EMISSIONS FROM TRANSPORTATION SOURCES IN THE PORTLAND, MAINE STUDY AREA, 1968 (Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Road Vehicles					
Gasoline Powered	680	910	190,140	14,320	9,680
Diesel Powered	160	450	250	560	910
Evaporative Losses	--	--	--	9,560	--
Totals	840	1,360	190,390	24,440	10,590
Aircraft					
Jet	0	0	10	20	10
Piston	0	20	3,730	710	170
Turboprop	0	0	10	0	10
Totals	0	20	3,750	730	190
Vessels	220	20	0	0	70
Railroads	110	300	160	370	600
STUDY AREA	1,170	1,700	194,300	25,540	11,450

SOLID WASTE

The solid waste source category is concerned with the air pollutant emissions caused by refuse disposal. Refuse includes not only the municipal refuse, but also refuse generated by commercial and industrial facilities. The primary means of disposing of refuse are: landfills, dumps, incinerators, and on-site burning. Only open burning dumps, incinerators and on-site burning are considered air pollutant sources.

METHODOLOGY: The total tons of refuse generated in the Portland area was determined by using the national generation rate of 10 pounds per person per day.[9] This total includes municipal, commercial and industrial refuse. In order to determine the amount of refuse being disposed of by each means of disposal, data was collected on all landfills, dumps and conical burners in the Study Area. The amount of refuse being disposed of by on-site incineration and on-site burning was determined with national averages.[12] These data were assembled into a refuse balance (Table 10).

The proportioning of the county totals into grids was done in three steps. The first was the accurate locating of all conical burners and open-burning dumps which had been surveyed. The refuse being disposed of by the remaining open-burning dumps was proportioned evenly into the rural grids of each county. The on-site burning and on-site incineration were distributed into grids on the basis of population.

RESULTS: Emissions caused by the open burning of refuse, contributed most of the emissions in the solid waste source category (Table 11). Open burning emissions, which were evenly divided between open burning dumps and on-site burning, ranged from 46 percent of the sulfur oxides to 93 percent of the hydrocarbons.

INDUSTRIAL PROCESSES

The industrial process category is concerned with all industrial air pollutant emissions inherent with the manufacturing of products. That portion of fuel which is used for process heating is included in the fuel combustion source category.

TABLE 10 SOLID WASTE DISPOSAL BALANCE FOR THE PORTLAND, MAINE STUDY AREA
1969 (Tons/Year)

County	Generation	Incineration		Landfills and Non-Burning Dumps	Open Burning Dumps	On-Site Burning	Conical Burning
		Municipal	On-Site				
Androscoggin County	242,000		36,000	30,000	110,000	66,000	
Cumberland County	343,000		51,000	150,000	40,000	87,000	15,000
Sagadahoc County	44,000		7,000		11,000	18,000	8,000
York County	187,000		28,000		95,000	64,000	
STUDY AREA	816,000		122,000	180,000	256,000	235,000	23,000

TABLE 11 AIR POLLUTANT EMISSIONS FROM SOLID WASTE DISPOSAL IN THE PORTLAND, MAINE STUDY AREA, 1969 (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Incineration					
Municipal	0	0	0	0	0
On-Site	120	610	2,680	50	180
Total	120	610	2,680	50	180
Open Burning					
Dumps	120	1,880	9,990	3,520	1,290
On-Site	140	2,240	11,910	4,200	1,540
Total	260	4,120	21,900	7,720	2,830
STUDY AREA	380	4,730	24,580	7,770	3,010

METHODOLOGY: Information concerning industrial processes was gathered on an individual plant basis. Each company was sent a questionnaire which asked for the appropriate data. The emission rates from industrial processes were estimated by using statndard emission factors published by the Department of Health, Education and Welfare.[2]

RESULTS: Air pollutant emissions are caused by only a few industrial processes in the Study Area. The industrial categories and emissions attributable to each are found in Table 12.

EVAPORATIVE LOSSES

The evaporative losses source category is concerned with emissions of hydrocarbons. The two primary sources studied in this category were dry cleaning and the automobile. There are a multitude of other domestic and commercial sources of evaporative losses, but these were not included because emission factors were not available.

METHODOLOGY: Dry cleaning emissions were estimated using factors based upon population.[2] The emissions were also proportioned into counties and grids using population. Evaporative losses by the automobile were estimated using vehicle mile activity. These emissions were distributed in the same manner the other automobile emissions were distributed.

RESULTS: The automobile was the largest single source in the evaporative losses category with 9,600 tons of hydrocarbons (Table 13). Dry cleaning contributed about 800 tons. In the Study Area evaporative losses accounted for 30 percent of all hydrocarbons emitted.

TABLE 12 AIR POLLUTANT EMISSIONS FROM INDUSTRIAL PROCESS IN THE PORTLAND, MAINE STUDY AREA, 1969 (Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Concrete	0	20	0	0	0
Foundry	0	--	150	0	0
Pulp and Paper	0	1,670	0	0	0
TOTAL	0	1,690	150	0	0

TABLE 13 HYDROCARBON EMISSIONS FROM EVAPORATIVE LOSSES IN THE PORTLAND, MAINE STUDY AREA, 1969 (Tons/Year)

Dry Cleaning	780
Automobile	9,560
TOTAL	10,340

EMISSIONS BY JURISDICTION

The previous section presented air pollutant emissions by source category. In order to show the contribution of each county to the air pollution in the Study Area, their emissions are summarized in Tables 14 through 17.

TABLE 14 SUMMARY OF AIR POLLUTANT EMISSIONS IN ANDROSCOGGIN COUNTY, 1969 (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Road Vehicles	140	130	31,470	2,460	1,750
Others	40	70	40	80	140
Total	180	200	31,510	2,540	1,890
Stationary Fuel Combustion					
Industry	910	170	20	20	610
Steam-Electric	0	0	0	0	0
Residential	740	170	220	80	230
Commercial-Institutional	0	0	0	0	10
Total	1,650	340	240	100	850
Solid Waste Disposal					
Incineration	40	180	790	10	50
Open Burning	90	1,430	7,610	2,690	980
Total	130	1,610	8,400	2,700	1,030
Industrial Processes	--	10	--	--	--
Evaporative Losses	--	--	--	1,750	--
TOTAL ALL SOURCES	1,960	2,160	40,150	7,090	3,770

TABLE 15 SUMMARY OF AIR POLLUTANT EMISSIONS IN CUMBERLAND COUNTY
1969 (Tons/Year)

Source Category	Sulfur Oxides	Partic-ulates	Carbon Monoxide	Hydro-carbons	Nitrogen Oxides
Transportation					
Road Vehicles	400	650	90,700	7,090	5,040
Others	220	180	3,830	900	520
Total	620	830	94,530	7,990	5,560
Stationary Fuel Combustion					
Industry	5,300	620	60	60	2,190
Steam-Electric	10,280	460	0	150	4,800
Residential	2,160	500	960	270	540
Commercial-Institutional	0	0	0	0	0
Total	17,740	1,580	1,020	480	7,530
Solid Waste Disposal					
Incineration	50	250	1,120	20	80
Open Burning	70	1,160	6,160	2,170	800
Total	120	1,410	7,280	2,190	880
Industrial Processes	0	1,680	150	0	0
Evaporative Losses	--	--	--	4,920	--
TOTAL ALL SOURCES	18,480	5,500	102,980	15,580	13,970

TABLE 16 SUMMARY OF AIR POLLUTANT EMISSIONS IN SAGADAHOC COUNTY 1969 (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Road Vehicles	50	80	11,330	890	630
Others	10	20	10	20	40
Total	60	100	11,340	910	670
Stationary Fuel Combustion					
Industry	590	80	10	10	280
Steam-Electric	7,400	330	0	110	3,460
Residential	310	70	130	40	70
Commercial-Institutional	0	0	0	0	0
Total	8,300	480	140	160	3,810
Solid Waste Disposal					
Incineration	10	40	150	0	10
Open Burning	20	300	1,570	560	200
Total	30	340	1,720	560	210
Industrial Processes	0	0	0	0	0
Evaporative Losses	--	--	--	620	--
TOTAL ALL SOURCES	8,390	920	13,200	2,250	4,690

TABLE 17 SUMMARY OF AIR POLLUTANT EMISSIONS IN YORK COUNTY
1969 (Tons/Year)

Source Category	Sulfur Oxides	Particulates	Carbon Monoxide	Hydrocarbons	Nitrogen Oxides
Transportation					
Road Vehicles	250	410	56,890	4,450	3,160
Others	60	80	40	100	170
Total	310	490	56,930	4,550	3,330
Stationary Fuel Combustion					
Industry	880	160	20	20	670
Steam-Electric	0	0	0	0	0
Residential	1,000	220	330	110	250
Commercial-Institutional	0	0	0	0	0
Total	1,880	380	350	130	920
Solid Waste Disposal					
Incineration	30	140	620	10	40
Open Burning	80	1,230	6,550	2,310	850
Total	110	1,370	7,170	2,320	890
Industrial Processes	0	0	0	0	0
Evaporative Losses	--	--	--	3,060	0
TOTAL ALL SOURCES	2,300	2,240	64,450	10,060	5,140

EMISSIONS BY GRID

For the purpose of defining the geographical variation in air pollutant emissions in the Study Area, the emissions were apportionned onto a grid coordinate system. The emissions were divided into two source groups--point sources and area sources. Thirty-five point sources are presented individually in Table 18. Each of these point sources emitted more than 0.25 tons per day of a pollutant. The approximate location of these point sources are shown in Figure 5. Area sources which made up the balance of emissions have not been presented separately, but have been combined with the point source emissions and presented with emissions from all sources in Table 19.

In order to present a visual representation of the emissions of pollutants by grid, emission density maps have been prepared. Emission densities were obtained by summing the annual area and point source emissions for each grid and dividing this total by the land area of the grid. Figures 6 through 10 show the variation in emission densities for the respective grids throughout the Study Area.

NOT REPRODUCIBLE

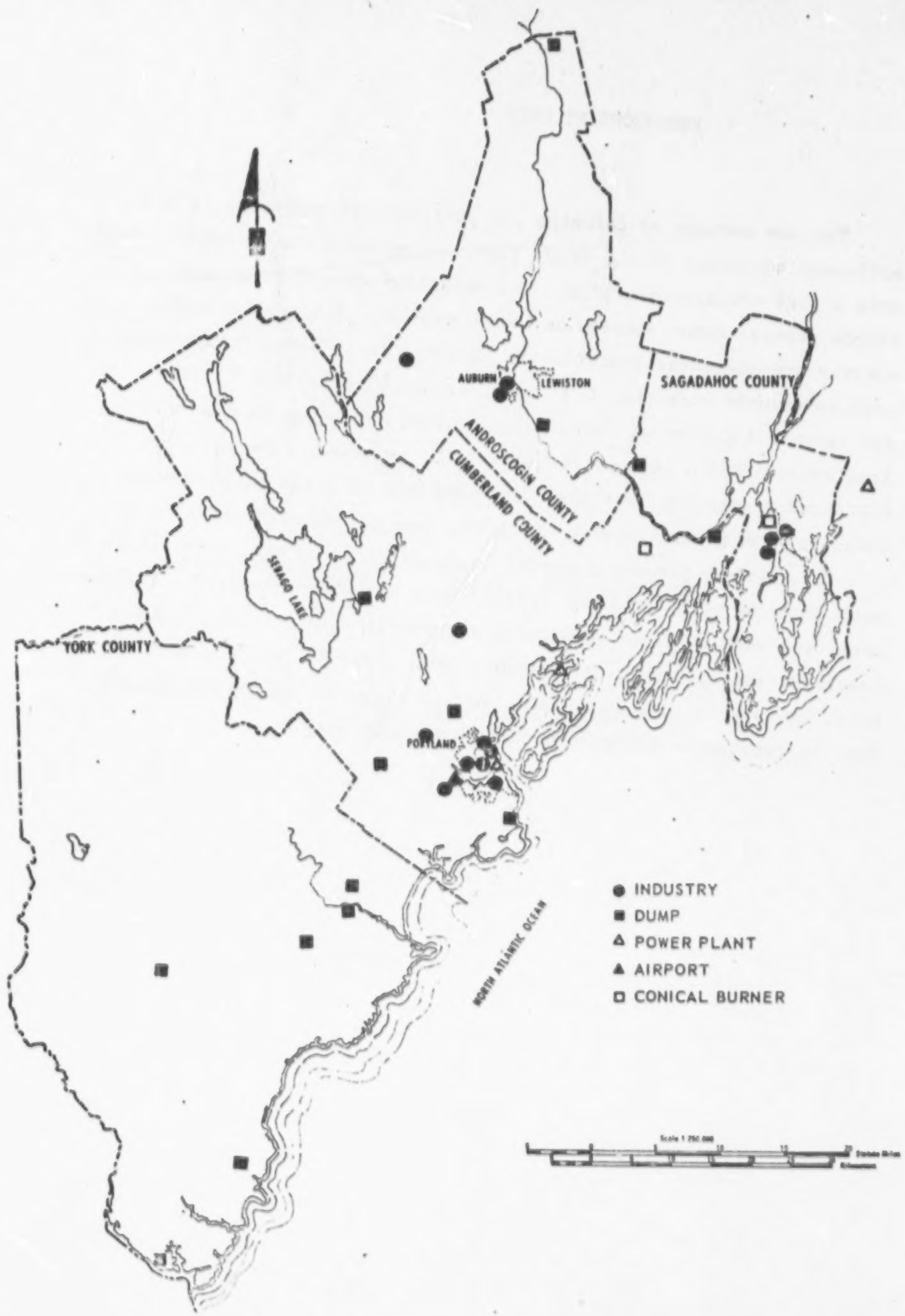


Figure 5. Point source location map for Portland, Maine study area, 1969.

TABLE 18 SUMMARY OF AIR POLLUTANT EMISSIONS FROM POINT SOURCES IN THE STUDY AREA (Tons/Year)

Source Category	Grid	HC	VC	SOx			PART.			CO			HC			NOx		
				S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
Dump	1	4075	49250	0.0	0.0	0.0	0.10	0.10	0.10	0.53	0.53	0.53	0.18	0.18	0.18	0.06	0.06	0.06
Industry	10	3880	48850	0.5	0.8	0.7	0.06	0.09	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.28	0.23
Industry	14	4020	48820	0.4	0.6	0.5	0.04	0.06	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.21	0.17
Industry	14	4010	48810	0.3	0.4	0.3	0.03	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.14	0.12
Dump	20	4050	48775	0.1	0.1	0.1	2.09	2.09	2.09	11.11	11.11	11.11	3.92	3.92	2.92	1.43	1.43	1.43
Dump	21	4175	48720	0.0	0.0	0.0	0.09	0.09	0.09	0.51	0.51	0.51	0.18	0.18	0.18	0.06	0.06	0.06
Conical Burner	26	4190	48605	0.0	0.0	0.0	0.33	0.33	0.33	1.79	1.79	1.79	0.63	0.63	0.63	0.23	0.23	0.23
Dump	27	4270	48640	0.0	0.0	0.0	0.14	0.14	0.14	0.75	0.75	0.75	0.26	0.26	0.26	0.09	0.09	0.09
Industry	28	4340	48620	0.6	1.0	0.8	0.07	1.10	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.34	0.28
Industry	28	4345	48630	0.2	0.4	0.3	0.02	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.14	0.11
Industry	28	4350	48640	0.2	0.3	0.2	0.02	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.10	0.08
Conical Burner	28	4350	48660	0.0	0.0	0.0	0.16	0.16	0.16	0.87	0.87	0.87	0.30	0.30	0.30	0.11	0.11	0.11
Power Plant	29	4460	48700	19.7	25.4	20.2	0.88	1.14	0.91	0.00	0.00	0.00	0.28	0.36	0.29	9.21	11.90	9.47
Dump	30	3830	48560	0.0	0.0	0.0	0.10	0.10	0.10	0.58	0.58	0.58	0.20	0.20	0.20	0.07	0.07	0.07
Industry	31	3945	48520	0.6	0.9	0.8	0.06	0.10	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.32	0.26
Power Plant	45	4075	48450	26.3	33.7	25.9	1.18	1.51	1.16	0.00	0.00	0.00	0.37	0.48	0.37	12.30	15.75	12.14
Dump	46	3945	48415	0.0	0.0	0.0	0.10	0.10	0.10	0.55	0.55	0.55	0.19	0.19	0.19	0.07	0.07	0.07
Dump	52	3840	48350	0.0	0.0	0.0	0.13	0.13	0.13	0.71	0.71	0.71	0.25	0.25	0.25	0.09	0.09	0.09
Industry	53	3913	48375	10.2	10.4	10.3	5.44	5.46	5.45	0.07	0.07	0.07	0.07	0.07	0.07	2.73	2.78	2.76
Industry	54	3989	48368	0.2	0.3	0.3	0.02	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.12	0.10
Industry	54	3990	48352	0.2	0.4	0.3	0.03	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.14	0.11
Industry	55	3932	48321	0.2	0.3	0.2	0.01	0.05	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.19	0.16
Airport	55	3943	48332	0.0	0.0	0.0	0.07	0.07	0.07	10.27	10.27	10.27	1.99	1.99	1.99	0.51	0.51	0.51

NOT REPRODUCIBLE

TABLE 18 SUMMARY OF AIR POLLUTANT EMISSIONS FROM POINT SOURCES (Cont.)

Source Category	Grid	HC	VC	SOx			PART.			CO			HC			NOx		
				S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
Industry	56	3959	48339	0.2	0.4	0.3	0.02	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.14	0.11
Industry	56	3983	48349	0.0	0.0	0.0	0.05	0.08	0.07	0.41	0.41	0.41	0.00	0.00	0.00	0.08	0.13	0.11
Industry	56	3998	48327	0.2	0.3	0.2	0.05	0.08	0.06	0.00	0.01	0.00	0.00	0.01	0.00	0.24	0.36	0.30
Power Plant	56	3990	48345	1.4	1.5	2.1	0.06	0.07	0.09	0.00	0.00	0.00	0.02	0.02	0.03	0.65	0.73	1.01
Dump	62	4010	48275	0.0	0.0	0.0	0.14	0.14	0.14	0.78	0.78	0.78	0.27	0.27	0.27	0.10	0.10	0.10
Dump	67	3750	48135	0.0	0.0	0.0	0.12	0.12	0.12	0.68	0.68	0.68	0.24	0.24	0.24	0.08	0.08	0.08
Dump	68	3805	48170	0.0	0.0	0.0	0.65	0.65	0.65	3.49	3.49	3.49	1.23	1.23	1.23	0.45	0.45	0.45
Dump	68	3810	48195	0.0	0.0	0.0	0.20	0.20	0.20	1.06	1.06	1.06	0.37	0.37	0.37	0.13	0.13	0.13
Dump	70	3580	48095	0.0	0.0	0.0	0.31	0.31	0.31	1.65	1.65	1.65	0.58	0.58	0.58	0.21	0.21	0.21
Dump	79	3680	47840	0.0	0.0	0.0	0.10	0.10	0.10	0.53	0.53	0.53	0.18	0.18	0.18	0.06	0.06	0.06
Dump	80	3575	47730	0.0	0.0	0.0	0.17	0.17	0.17	0.93	0.93	0.93	0.32	0.32	0.32	0.12	0.12	0.12

TABLE 19 SUMMARY OF AIR POLLUTANT EMISSIONS FROM ALL SOURCES
TONS/DAY

		SOx			PART			CO			HC			NOX		
GRID	AREA	S	W	A	S	W	A	S	W	A	S	W	A	S	W	A
1	38.6	0.0	0.1	0.1	0.7	0.2	0.7	5.1	3.9	4.4	0.8	0.7	0.8	0.4	0.4	0.4
2	38.6	0.0	0.1	0.1	0.1	0.1	0.1	3.4	2.6	2.9	0.5	0.4	0.5	0.2	0.2	0.2
3	38.6	0.0	0.0	0.0	0.0	0.0	0.0	2.3	1.6	1.9	0.3	0.2	0.3	0.1	0.1	0.1
4	38.6	0.0	0.1	0.0	0.1	0.1	0.1	1.3	1.0	1.1	0.2	0.2	0.2	0.1	0.1	0.1
5	38.6	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.5	0.5	0.1	0.1	0.1	0.1	0.0	0.0
6	38.6	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.9	1.0	0.2	0.1	0.1	0.1	0.1	0.1
7	38.6	0.0	0.1	0.1	0.1	0.1	0.1	4.7	3.4	3.9	0.7	0.5	0.6	0.3	0.3	0.3
8	38.6	0.0	0.0	0.0	0.0	0.0	0.0	1.9	1.4	1.6	0.3	0.2	0.2	0.1	0.1	0.1
9	154.4	0.1	0.2	0.1	0.2	0.2	0.2	8.4	6.2	7.0	1.2	0.9	1.0	0.5	0.5	0.5
10	38.6	0.6	1.0	0.9	0.7	0.2	0.7	3.9	2.9	3.3	0.6	0.5	0.5	0.5	0.6	0.5
11	38.6	0.0	0.1	0.1	0.1	0.1	0.1	3.8	2.8	3.2	0.5	0.4	0.5	0.3	0.2	0.2
12	9.6	0.0	0.1	0.1	0.1	0.1	0.1	5.1	3.7	4.2	0.7	0.5	0.6	0.3	0.3	0.3
13	9.6	0.0	0.1	0.1	0.1	0.1	0.1	1.1	0.9	0.9	0.2	0.2	0.2	0.1	0.1	0.1
14	9.6	1.6	4.8	3.2	1.9	2.5	2.7	44.6	34.6	38.2	7.0	5.9	6.2	4.0	4.7	4.2
15	9.6	0.1	0.2	0.1	0.1	0.2	0.2	6.5	4.8	5.4	0.9	0.7	0.8	0.4	0.4	0.4
16	38.6	0.0	0.1	0.1	0.1	0.1	0.1	5.9	4.2	4.8	0.8	0.6	0.7	0.3	0.3	0.3
17	154.4	0.1	0.3	0.2	0.3	0.2	0.3	9.4	6.9	7.8	1.4	1.0	1.2	0.6	0.5	0.6
18	38.6	0.0	0.1	0.0	0.1	0.1	0.1	3.0	2.2	2.5	0.4	0.3	0.4	0.2	0.2	0.2
19	38.6	0.1	0.1	0.1	0.1	0.1	0.1	10.1	7.3	8.3	1.4	1.0	1.1	0.6	0.5	0.5
20	38.6	0.5	0.9	0.7	2.4	2.4	2.4	20.4	14.8	16.9	2.3	2.0	2.1	1.2	1.2	1.2
21	38.6	0.1	0.3	0.1	0.3	0.3	0.3	8.0	6.0	6.7	1.2	1.0	1.1	0.6	0.5	0.5
22	154.4	0.0	0.1	0.1	0.1	0.1	0.1	5.9	4.4	5.0	0.9	0.7	0.7	0.4	0.3	0.3
23	38.4	0.0	0.1	0.0	0.0	0.0	0.0	1.5	1.1	1.2	0.2	0.2	0.2	0.1	0.1	0.1
24	38.6	0.1	0.1	0.1	0.2	0.2	0.2	9.7	7.1	8.1	1.4	1.0	1.2	0.6	0.5	0.5
25	38.6	0.0	0.1	0.0	0.1	0.1	0.1	1.7	1.2	1.4	0.3	0.2	0.2	0.1	0.1	0.1

NOT REPRODUCIBLE

28	38.6	0.1	0.2	0.1	0.5	0.5	0.5	9.9	7.7	8.5	1.8	1.5	1.6	0.7	0.7	0.7
27	38.6	0.2	0.8	0.5	0.6	0.6	0.6	24.7	18.3	20.7	3.6	2.8	3.1	1.6	1.4	1.5
28	38.6	1.4	3.0	2.2	0.7	1.0	0.9	17.7	13.9	15.2	2.9	2.4	2.6	1.7	2.0	1.8
29	38.6	19.7	25.5	20.3	0.9	1.2	0.9	1.3	0.9	1.1	0.5	0.5	0.4	9.3	12.0	9.5
30	38.6	0.1	0.1	0.1	0.2	0.2	0.2	9.2	6.7	7.6	1.3	1.0	1.2	0.6	0.5	0.5
31	38.6	0.7	1.2	1.0	0.3	0.3	0.3	13.6	9.9	11.3	1.9	1.4	1.6	1.1	1.0	1.0
32	38.6	0.1	0.2	0.1	0.1	0.1	0.1	11.8	8.5	9.7	1.6	1.2	1.3	0.7	0.6	0.6
33	38.6	0.0	0.1	0.1	0.2	0.2	0.2	7.1	5.2	5.9	1.1	0.8	0.9	0.5	0.4	0.4
34	38.6	0.0	0.2	0.1	0.1	0.1	0.1	5.5	4.0	4.6	0.8	0.6	0.7	0.3	0.3	0.3
35	38.6	0.0	0.1	0.1	0.1	0.1	0.1	2.9	2.1	2.4	0.4	0.3	0.4	0.2	0.2	0.2
36	38.6	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0
37	38.6	0.0	0.1	0.0	0.1	0.1	0.1	1.3	1.0	1.1	0.2	0.2	0.2	0.1	0.1	0.1
38	154.4	0.1	0.2	0.1	0.1	0.1	0.1	4.9	2.8	3.6	0.7	0.4	0.5	0.3	0.2	0.3
39	38.6	0.0	0.1	0.1	0.1	0.1	0.1	3.4	2.1	2.6	0.5	0.3	0.4	0.2	0.2	0.2
40	38.6	0.0	0.1	0.1	0.1	0.1	0.1	4.7	3.4	3.9	0.6	0.5	0.5	0.3	0.3	0.3
41	38.6	0.1	0.2	0.1	0.1	0.2	0.2	9.0	6.5	7.4	1.2	0.9	1.0	0.6	0.5	0.5
42	9.6	0.0	0.1	0.1	0.1	0.1	0.1	5.0	3.7	4.2	0.7	0.6	0.6	0.3	0.3	0.3
43	9.6	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.7	0.8	0.2	0.1	0.1	0.1	0.1	0.1
44	9.6	0.0	0.1	0.1	0.1	0.1	0.1	6.1	4.4	5.0	0.8	0.6	0.7	0.4	0.3	0.3
45	9.6	26.4	33.7	26.0	1.3	1.6	1.2	1.2	0.9	1.0	0.6	0.7	0.6	12.4	15.8	12.2
46	9.6	0.1	0.2	0.1	0.2	0.2	0.2	8.3	6.1	6.9	1.2	1.0	1.1	0.5	0.5	0.5
47	9.6	0.0	0.0	0.0	0.1	0.1	0.1	5.3	3.8	4.4	0.7	0.5	0.6	0.4	0.3	0.3
48	9.6	0.0	0.1	0.1	0.1	0.1	0.1	7.0	5.0	5.7	0.9	0.7	0.8	0.4	0.3	0.4
49	154.4	0.1	0.2	0.1	0.1	0.1	0.1	4.7	2.7	3.4	0.7	0.5	0.6	0.3	0.3	0.3
50	38.6	0.0	0.1	0.1	0.0	0.1	0.0	1.3	0.8	1.0	0.2	0.1	0.2	0.1	0.1	0.1
51	38.6	0.1	0.2	0.1	0.1	0.1	0.1	3.7	2.3	2.8	0.5	0.4	0.4	0.3	0.2	0.2
52	38.6	0.1	0.4	0.3	0.4	0.4	0.4	14.1	10.5	11.8	2.1	1.7	1.8	0.9	0.9	0.9
53	9.6	10.5	11.1	10.9	5.9	5.9	5.8	15.4	11.3	12.8	2.2	1.7	1.9	4.0	4.1	4.0
54	9.6	1.4	4.3	2.8	0.8	1.4	1.1	32.1	24.9	27.4	4.6	3.8	4.0	2.7	3.1	2.9

NOT REPRODUCIBLE

55	9.6	0.3	0.9	0.6	0.4	0.5	0.4	24.4	20.6	22.0	4.0	3.6	3.7	1.6	1.6	1.5
56	9.6	3.2	8.3	6.4	1.6	2.7	2.1	53.0	41.7	45.5	7.7	6.6	6.9	5.4	5.3	6.1
57	9.6	0.7	1.9	1.3	0.9	0.5	0.4	7.5	6.1	6.6	1.1	1.0	1.0	0.8	1.0	0.8
58	38.6	0.0	0.1	0.1	0.1	0.1	0.1	3.4	1.8	2.4	0.5	0.3	0.4	0.2	0.2	0.2
59	38.6	0.1	0.2	0.1	0.1	0.1	0.1	4.3	2.3	3.1	0.6	0.4	0.5	0.3	0.2	0.3
60	38.6	0.2	0.5	0.3	0.3	0.3	0.3	23.5	14.5	17.9	3.2	2.0	2.5	1.4	1.1	1.2
61	38.6	0.1	0.6	0.4	0.3	0.4	0.3	17.6	12.8	14.6	2.5	1.9	2.1	1.1	1.0	1.0
62	9.6	0.0	0.1	0.1	0.2	0.2	0.2	2.8	2.2	2.4	0.6	0.5	0.5	0.2	0.2	0.2
63	9.6	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.7	0.8	0.1	0.1	0.1	0.1	0.1	0.1
64	38.6	0.0	0.0	0.0	0.0	0.0	0.0	1.2	0.7	0.9	0.2	0.1	0.1	0.1	0.1	0.1
65	38.6	0.2	0.6	0.4	0.3	0.3	0.3	10.6	5.8	7.6	1.6	1.0	1.2	0.8	0.7	0.7
66	38.6	0.1	0.1	0.1	0.1	0.1	0.1	5.0	2.6	3.5	0.7	0.4	0.5	0.3	0.2	0.2
67	38.6	0.2	0.3	0.2	0.3	0.3	0.3	14.8	8.1	10.7	2.2	1.3	1.6	1.0	0.7	0.8
68	38.6	0.7	1.8	1.2	1.6	1.7	1.7	37.6	22.4	28.2	5.4	4.5	5.2	3.0	2.6	2.7
69	38.6	0.0	0.1	0.1	0.1	0.1	0.1	3.1	1.7	2.2	0.5	0.3	0.4	0.2	0.2	0.2
70	38.6	0.2	0.6	0.4	0.5	0.6	0.6	12.3	7.4	9.3	2.1	1.5	1.7	1.0	0.8	0.9
71	38.6	0.1	0.2	0.1	0.1	0.1	0.1	3.6	1.9	2.6	0.5	0.3	0.4	0.2	0.2	0.2
72	38.6	0.2	0.3	0.2	0.2	0.2	0.2	19.4	10.3	13.6	2.6	1.4	1.8	1.2	0.7	0.9
73	38.6	0.1	0.2	0.1	0.1	0.2	0.2	4.4	2.5	3.2	0.7	0.5	0.5	0.3	0.3	0.3
74	38.6	0.0	0.1	0.1	0.0	0.0	0.0	2.4	1.3	1.7	0.3	0.2	0.2	0.2	0.1	0.1
75	38.6	0.1	0.2	0.1	0.2	0.2	0.2	7.5	4.2	5.4	1.1	0.7	0.9	0.5	0.4	0.4
76	38.6	0.1	0.2	0.2	0.3	0.2	0.2	16.2	8.5	11.4	2.2	1.3	1.6	1.0	0.6	0.8
77	38.6	0.0	0.0	0.0	0.0	0.0	0.0	4.3	2.2	3.0	0.6	0.3	0.4	0.2	0.1	0.2
78	38.6	0.2	0.3	0.2	0.2	0.2	0.2	6.6	3.6	4.7	1.0	0.6	0.8	0.6	0.5	0.5
79	38.6	0.2	0.2	0.2	0.3	0.3	0.3	19.6	10.3	13.8	2.7	1.5	2.0	1.2	0.7	0.9
80	38.6	0.5	2.6	1.5	0.7	1.1	0.9	28.6	17.1	21.3	4.2	2.9	3.3	2.0	1.7	1.8
81	38.6	0.1	0.2	0.2	0.2	0.1	0.1	13.0	6.7	9.1	1.7	0.9	1.2	0.8	0.5	0.6

NOT REPRODUCIBLE

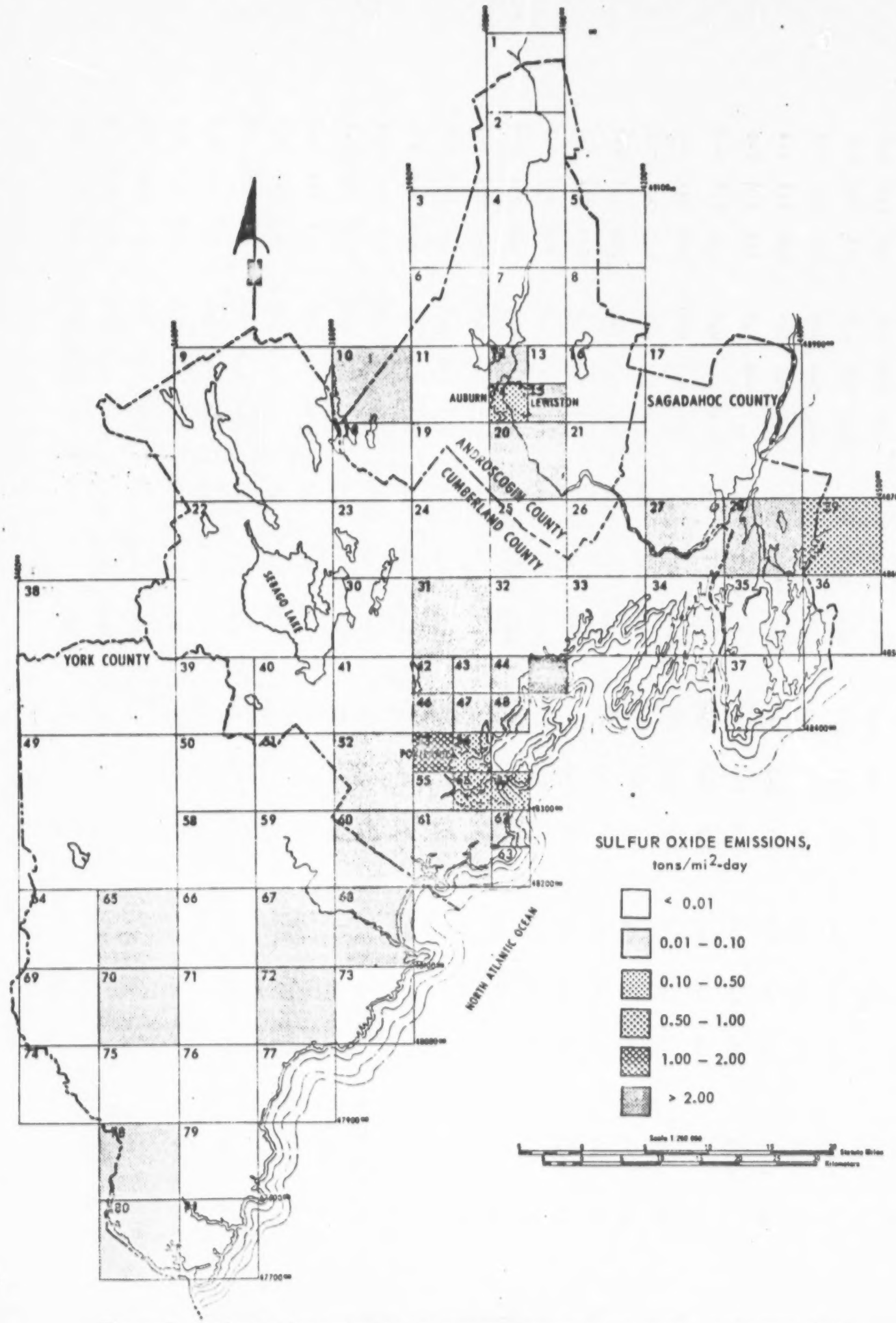
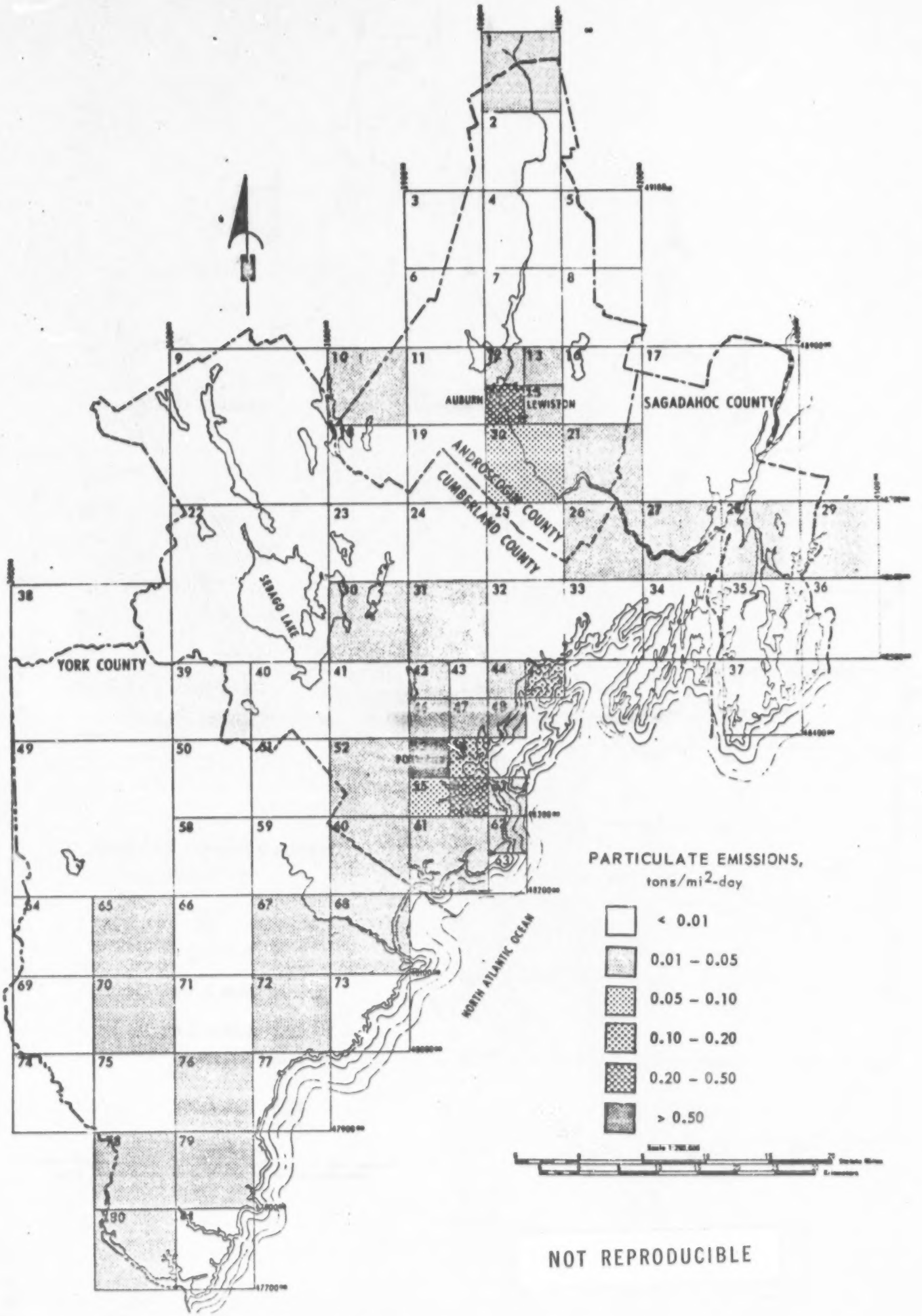
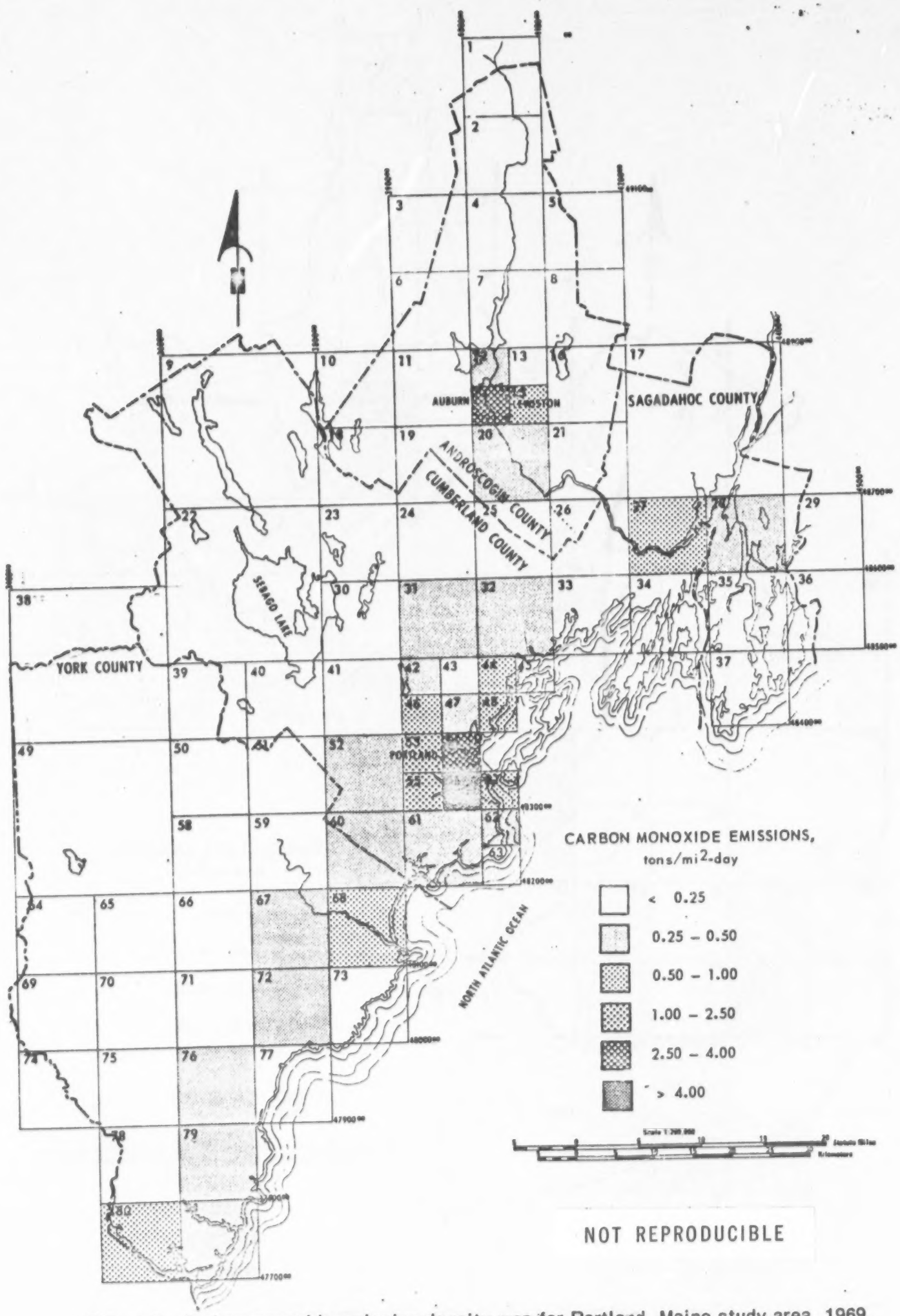


Figure 6. Sulfur oxides emission density map for Portland, Maine study area, 1969.



NOT REPRODUCIBLE

Figure 7. Particulate emission density map for Portland, Maine study area, 1969.



NOT REPRODUCIBLE

Figure 8. Carbon monoxide emission density map for Portland, Maine study area, 1969.

NOT REPRODUCIBLE

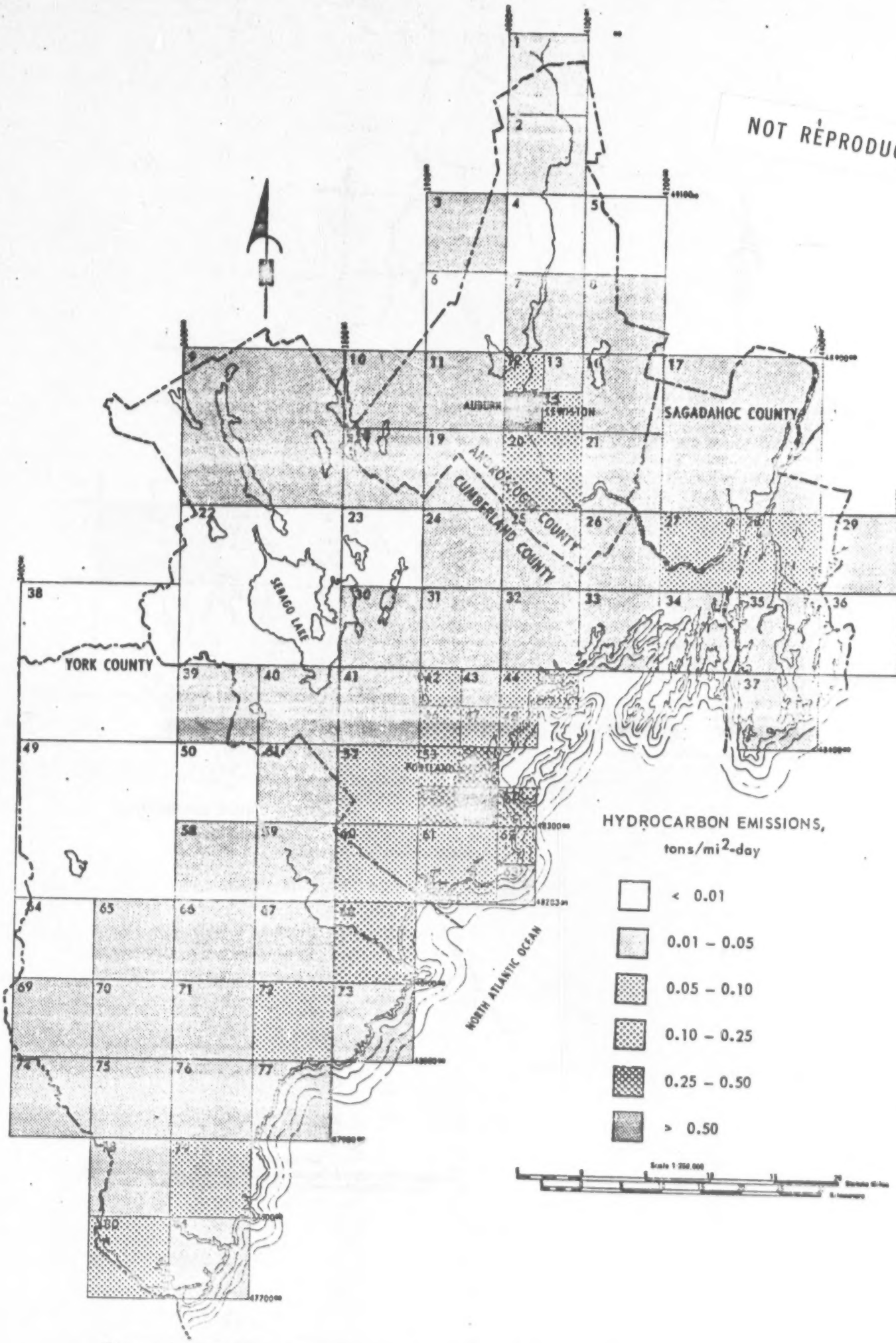


Figure 9. Hydrocarbon emission density map for Portland, Maine study area, 1969.

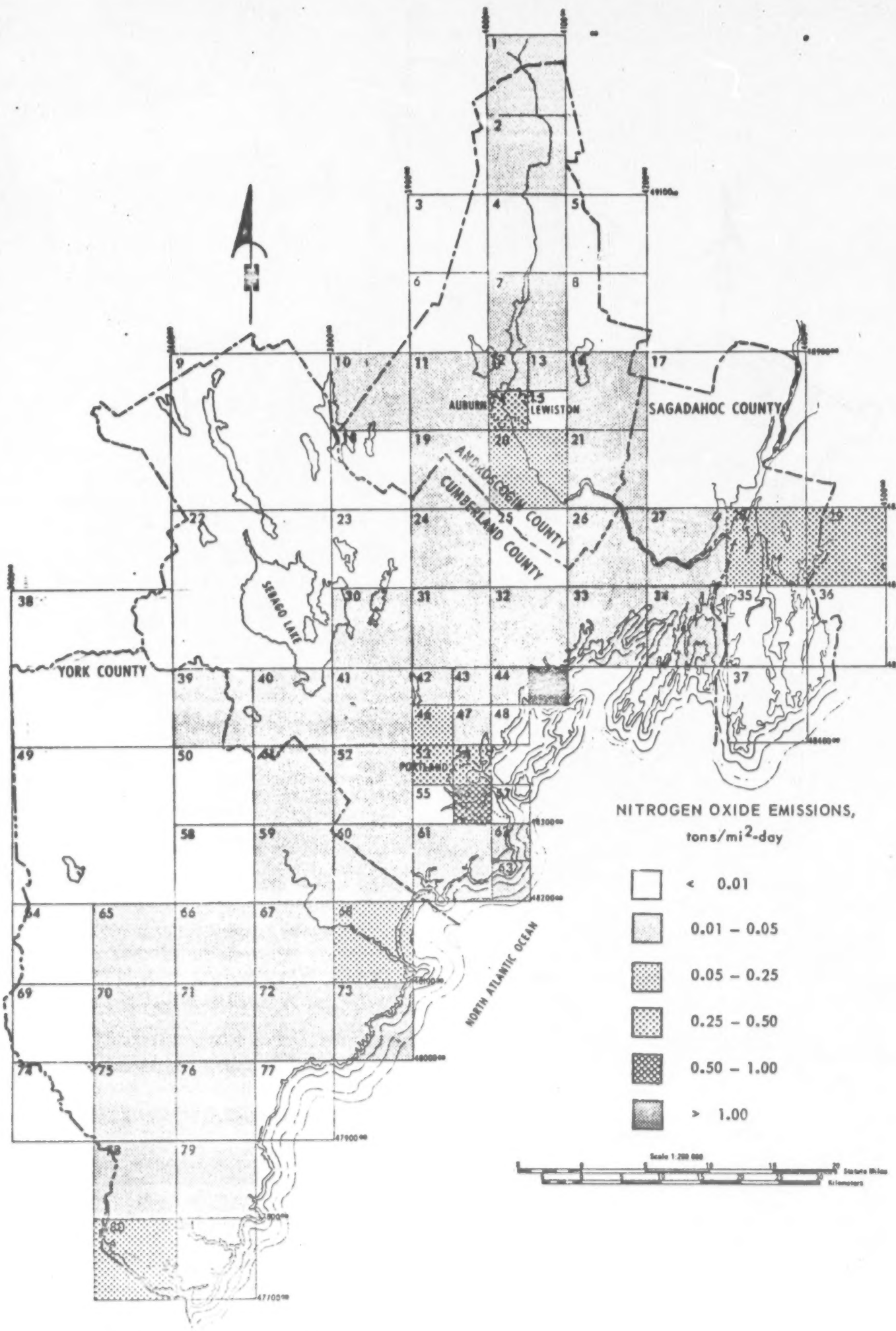


Figure 10. Nitrogen oxide emission density map for Portland, Maine study area, 1969.

REFERENCES

1. Ozolins, G. and Smith, R., Rapid Survey Technique for Estimating Community Air Pollution, DHEW,PHS, October 1966.

2. Duprey, R. L., Compilation of Air Pollution Emission Factors, DHEW,PHS, April 1967.

3. United States Census of Housing: 1960 - Utah, United States Department of Commerce, Bureau of the Census.

4. United States Census of Population: 1960 - Utah, United States Department of Commerce, Bureau of the Census.

5. Personal Communication with Maine State Department of Highways

6. 1963 Census of Business: Retail Trade, United States Department of Commerce, Bureau of the Census.

7. Highway Statistics/1968, United States Department of Transportation.

8. Petroleum Facts and Figures, American Petroleum Institute.

9. 1968 National Survey of Community Solid Waste Practice, Interim Report, DHEW,PHS

10. Personal Communication with Utah Division of Health, Air Quality Section.

11. Mineral Industry Surveys, Burner Fuel Oils, 1967, United States Department of Interior, Bureau of Mines.

12. National Air Pollution Control Administration Reference Book of Nation Wide Emissions, 1968.

13. FAA Air Traffic Activity, Federal Aviation Administration, Department of Transportation, 1969.

APPENDIX A

METHOD FOR CALCULATING SUMMER, WINTER AND ANNUAL AVERAGE EMISSIONS FOR FUEL CONSUMPTION IN STATIONARY SOURCES

YEARLY AVERAGE (A)

$$A = \frac{\text{Fuel Consumed} \times \text{Emission Factor (E. F.)}}{\text{Days of Operation}}$$

e.g. A plant consumed 100,000 tons of coal in 1967 while operating 365 days. The total degree days for the area was 4,800 and 2,800 for the three winter months. The plant was estimated to use 15 percent of the fuel for space heating and 85 percent for process heating. From this information, the annual average emission for carbon monoxide would be the following:

$$A = \frac{100{,}000 \text{ Tons/year} \times 3 \text{ lbs. CO/Ton coal}}{365 \text{ Days/year} \times 2{,}000 \text{ lb./Ton}}$$

$$A = 0.41 \text{ Ton/Day}$$

WINTER AVERAGE (W)

$$W = \frac{\text{Fuel Consumed} \times \text{E.F.}}{\text{Days of Winter Operation}} \times \frac{\text{Winter Degree Days}}{\text{Total Degree Days}} \times \text{\% Fuel Used for space heating}$$

$$+ \frac{\text{Fuel Consumed} \times \text{E.F.}}{365} \times \text{\% Fuel used for process heating}$$

$$W = \left[\frac{100{,}000 \times 2{,}800}{90 \times 4{,}800} \times 0.15 + \frac{100{,}000}{365} \times 0.85\right] \frac{3}{2{,}000}$$

$$W = 0.49 \text{ Ton/Day}$$

SUMMER AVERAGE (S)

$$S = \frac{\text{Fuel Consumed} \times \text{E.F.}}{\text{Days of Summer Operation}} \times \frac{\text{Summer Degree Days}}{\text{Total Degree Days}} \times \text{\% Fuel Used for space heating}$$

$$+ \frac{\text{Fuel Consumed} \times \text{E.F.}}{365} \times \text{\% Fuel used for process heating}$$

$$S = \left[\frac{100{,}000}{90} \times \frac{0}{4{,}800} \times 0.15 + \frac{100{,}000}{365} \times 0.85\right] \frac{3}{2{,}000}$$

$$S = 0.35 \text{ Ton/Day}$$

APPENDIX B

METRIC CONVERSION FACTORS

Multiply	By	To Obtain
Feet	0.3048	Meters
Miles	1609	Meters
Square Feet	0.0929	Square Meters
Square Miles	2.59	Square Kilometers
Pounds	453.6	Grams
Pounds	$453.6/10^4$	Tons (metric)
Tons (metric)	1.103	Tons (short)
Tons (short)	907.2	Kilograms
Tons (short)	.9072	Tons (metric)

To Obtain	By	Divide